National Institute of Environmental Health Sciences

Chemical ecology in coupled human and natural systems: People, manioc, multitrophic interactions and global change

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Year: 2010
Journal: Chemoecology. 20 (2): 109-133

Abstract:

Chemical ecology provides unique perspectives for managing plant/human interactions to achieve food security. Allelochemicals function as chemical defences of crop plants, enhancing yields. While ingested allelochemicals can confer health benefits to humans, at higher concentrations they are often toxic. The delicate balance between their positive and negative effects in crop plants is influenced by many factors. Some of these-how environment affects optimal levels of defence, how metabolic interactions with nutrients affect toxicity of ingested allelochemicals-are the province of chemical ecology. These biological factors, however, interact with social factors, and neither can be studied independently. Chemical ecologists must work together with social scientists to understand the overall system. Here, we illustrate such an integrative approach, analysing the interactions between people and the major tropical crop manioc, which contains cyanogenic glucosides. Polymorphism for cyanogen levels in manioc facilitates analysis of how costs and benefits of crop defences vary among social systems. We first show how people/manioc interactions diversified in this crop's Amazonian homeland, then turn to the remarkable cultural adaptations of African farmers since manioc's introduction 400 years ago. Finally, we evaluate new coevolutionary challenges in parts of Africa where people are still unfamiliar with a potentially dangerous crop. Current environmental and social catastrophes have restricted farmers' options, resulting in acute problems in health of humans and ecosystems. We show that high cyanogen levels confer important agronomic advantages, but also impose costs and constraints that can only be understood when biology is coupled with analysis of social, cultural and economic factors. Detoxifying manioc technologically requires know-how, time, water and other resources. Detoxifying residual dietary cyanogens metabolically depends on being able to grow, or to buy, the nutrients required for detoxification, primarily sulphur-rich proteins. Solutions that appear adaptive today may not be in the future, as changing climate, rising atmospheric CO(2) levels and decreased access to fertilizers affect productivity of crops and the nutrient and allelochemical composition of the foods they are used to produce.

Source: http://dx.doi.org/10.1007/s00049-010-0047-1

Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Food/Water Quality, Food/Water Security

Food/Water Quality: Chemical

Geographic Feature: ☑

resource focuses on specific type of geography

Tropical

Geographic Location: ☑

resource focuses on specific location

Non-United States

Non-United States: Africa, Central/South America

Health Co-Benefit/Co–Harm (Adaption/Mitigation): ☑

specification of beneficial or harmful impacts to health resulting from efforts to reduce or cope with greenhouse gases

A focus of content

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Other Health Impact

Other Health Impact: Acute cyanide poisoning

Intervention: ☑

strategy to prepare for or reduce the impact of climate change on health

A focus of content

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Adaptation

Population of Concern: A focus of content

Population of Concern: ☑

populations at particular risk or vulnerability to climate change impacts

Children, Low Socioeconomic Status, Pregnant Women, Workers

Resource Type: ☑

format or standard characteristic of resource

Review

Timescale: ☑

time period studied

Time Scale Unspecified

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content